Coupling habitat exposure to nitrogen and species sensitivity to hypoxia – LCIA methodology applied to marine eutrophication

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Publication date:
2014

IARU Sustainability Science Congress

GLOBAL CHALLENGES:
ACHIEVING SUSTAINABILITY

Wednesday 22nd – Friday 24th of October 2014
At the Radisson Blu Falconer Hotel & Conference Center, Copenhagen
Organised by the International Alliance of Research Universities (IARU)
and hosted by the University of Copenhagen

Session: Sustainable nutrient management in the Anthropocene

Oral presentation, October 24th 2014

Abstract ID-number: 108

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Abstract

Characterisation modelling in Life Cycle Impact Assessment (LCIA) aims at developing sound methods and tools to estimate potential impacts to ecosystems and humans. Ecological and environmental impacts arising from marine eutrophication can be caused by excessive oxygen depletion as a result of anthropogenic emissions of nitrogen (N) from e.g. agriculture and industry. Characterisation Factors (CF) in LCIA are used to translate emissions into potential impacts, traditionally by modelling fate, exposure and effects of the emitted substances. The present work builds on ecological and biological processes and couples marine habitat exposure to N and marine species sensitivity to hypoxia. The habitat exposure model explains the incorporation of N into planktonic biomass and subsequent respiration of the organic carbon in bottom waters where dissolved oxygen (DO) is consumed, delivering an exposure factor (XF). The effect model quantifies the sensitivity of the ecosystems receiving the N emissions (and where the DO is depleted) based on the sensitivity of the resident marine benthic and demersal species to deliver the potential loss of species as an effect factor (EF). Coupling habitat exposure (XF) and effects on resident biota (EF) seems a useful contribution to the estimation of CFs in LCIA where the damage dimension of the impacts to the ecosystem is given by the potential loss of biodiversity per mass of substance emitted. The application of such impact methods in estimating Life Cycle Assessment (LCA) indicators ultimately helps to quantitatively assess the environmental sustainability of human-based product systems and services.

Keywords: Nitrogen, Exposure, Effects, Hypoxia, Eutrophication